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(54) A miniature electric motor with a spark-quenching element.

(57) A miniature motor comprises a cylindrical housing (1) closed at one end with an end cap (6) closing the open end ; a permanent magnet (2) fitted to the inner surface of the housing (1) ; a rotor (5) supported in bearings (9,10) in the housing (1) and end cap (6). The rotor includes an armature (3) and a commutator (4) which makes sliding contact with brushes (7) fitted to the end cap (6). Input terminals (8) in the end cap (6) are electrically connected to the brushes (7), and a spark-quenching element in the form of a laminated ceramic capacitor formed into a ring (18) is mounted on the rotor (5). The spark-quenching element has on its outer surface the same number of electrodes (19) as the number of poles of the armature (3). The electrostatic capacity of the capacitor is preferably more than 1 μF.

FIG. 6

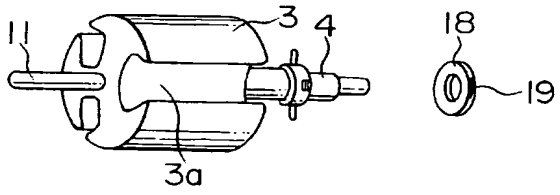
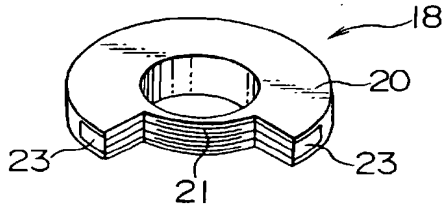


FIG. 7



EP 0 551 740 A1

The spark-quenching element just described requires a total of four components, i.e., the plate 12 and three electrolytic capacitors 13, complicating rotor assembly. Since the electrolytic capacitors 13 are fitted in the slots 3a of the armature 3, as shown in Figures 2, there is also a space limitation. If the electrostatic capacity of the capacitors 13 is to increase, the space available for the coil 3b that determines the torque of a miniature motor is accordingly limited. Further, when fitting the electrolytic capacitors 13, the insulating coating of the coil 3b may be damaged, causing shortcircuiting between layers. Also, the lead wires 13a of the electrolytic capacitors 13, where they protrude from the plate 12 can hamper efforts to reduce the thickness of the motor.

The spark-quenching element, shown in Figures 3 is substantially as disclosed in Japanese Published Utility Model Application No. 14709/1976, for example. In this example, a plate 15 made of an insulating material has a ring shape and a plurality of electrodes 16 applied on the surface thereof, chip capacitors 17 being mounted across electrodes 16. When chip capacitors 17 having a large capacity are used, however, their thickness increases, and so does the thickness of the plate 15. This also hampers efforts to reduce the overall dimensions of the motors.

Japanese Published Utility Model Application No. 42457/1976 discloses the use of washer-type varistors as spark-quenching elements. In this example, a plurality of divided electrodes are formed on at least the circumferential surface of a varistor proper formed into an annular shape, with the electrostatic capacity of the varistor being as small as dozens of nF. At high voltages over 30 V, for example, the dispersion of varistor voltage becomes extremely large, increasing the dispersion of the spark-quenching effect. Further the electrostatic capacity becomes as small as a few nF in inverse proportion to the varistor voltage.

In miniature motors using voltages as low as 2.4 V for example, a large current is needed to obtain high power. The service life of a miniature motor can be improved by the characteristics of the varistor proper so long as the voltage is within the range of 2.4 - 30 V. When varistors are used in a miniature motor having a high-voltage specification with a motor terminal voltage of over 30 V, as described above, and one having a large-current and high-output specification of under 2.4 V, the electrostatic capacity of the spark-quenching element could be insufficient.

According to the embodiment of the invention shown in Figures 5 and 6, a spark-quenching element 18 comprises a laminated ceramic capacitor made of a highly dielectric ceramic material, such as barium titanate, which will be described later. The element 18 is formed into a ring shape and fitted to the shaft 11 between the armature 3 and the commutator 4. It has on its outer periphery the same number (three in this embodiment) of electrodes 19 as the number of poles of the armature 3.

Figure 7 is a partly cutaway enlarged perspective view of the spark-quenching element 18 shown in Figures 5 and 6. Figure 8 is a diagram of assistance in explaining the construction of the internal electrodes of the aforementioned spark-quenching element 18. figures 9A and 9B are plan views illustrating major components of the aforementioned spark-quenching element 18. In Figures 7 to 9, numeral 20 identifies a ring-shaped thin sheet made of a highly dielectric material, such a barium titanate, and numeral 21 an internal electrode formed into a sector shape with the central angle thereof being 180 degrees. Each electrode 21 has a terminal 22 facing the outer circumferential surface thereof. The ring-shaped thin sheets 20 and the internal electrodes 21 are laminated alternately, and a capacitor is formed by the portions where the internal electrodes 21 overlap (as shown by shaded portions), as shown in Figure 8. An electrode 23 is connected to each terminal 22 to electrically connect the commutator 4 and the armature 3 shown in Figure 5.

Tests were conducted on miniature motors in which the spark-quenching elements of the type described above with reference to Figures 5 to 9 were incorporated. The tests were based upon continuous operation with an applied voltage of 38 volts d-c and a fan load of approximately 20g, and the results are shown below. In this test, I_0 = 210 mA, and N_0 = 22,000 rpm. In the table, the results for a miniature motor equipped with a varistor and one without a spark-quenching element are also shown at (4) and (5).

	Spark-quenching element	Electrostatic capacity (μF)	Life (h)
(1)	Laminated capacitor	1.5	650
(2)	Laminated capacitor	1.0	600
(3)	Laminated capacitor	0.5	250
(4)	Varistor	0.01	200
(5)	None	0	50

As is evident from the table above, the motor without spark-quenching element (Test 5) had a service life

projected plane orthogonally intersecting the axis.

4. A miniature motor according to any preceding Claim wherein the same number of sector-shaped electrodes (21) as the number or poles of armature (3) are provided on the end face of the laminated ceramic capacitor, and electrically connected to corresponding electrodes (23) provided on the outer circumferential surface thereof.

5. A miniature motor according to any pending Claim wherein the outer profile of the spark-quenching element (18) is circular.

6. A miniature motor according to any preceding Claim wherein the spark-quenching element (18) is fitted to the motor rotor (5).

FIG. 3A
(PRIOR ART)

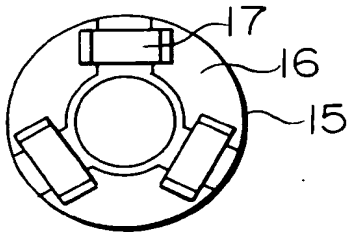


FIG. 3B
(PRIOR ART)

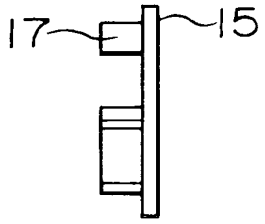


FIG. 4

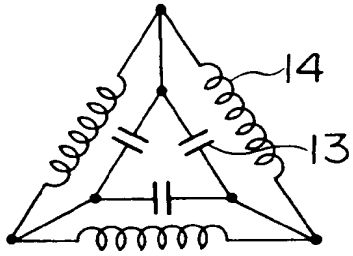


FIG. 5

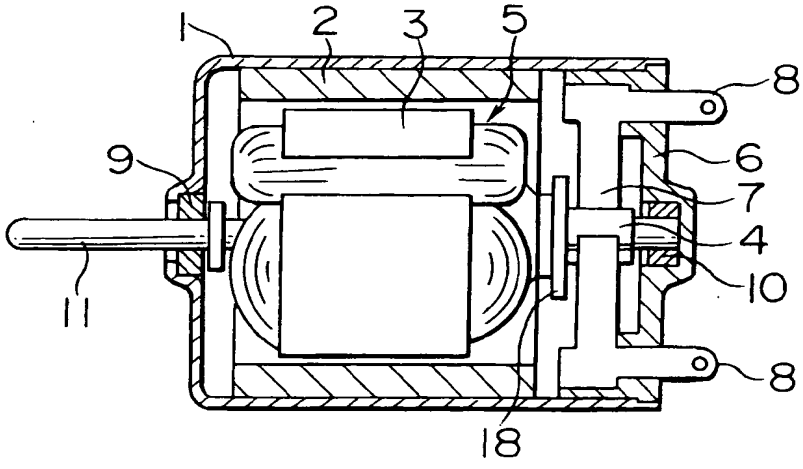


FIG. 9A

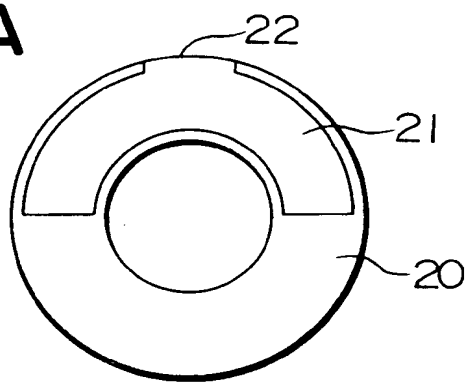


FIG. 9B

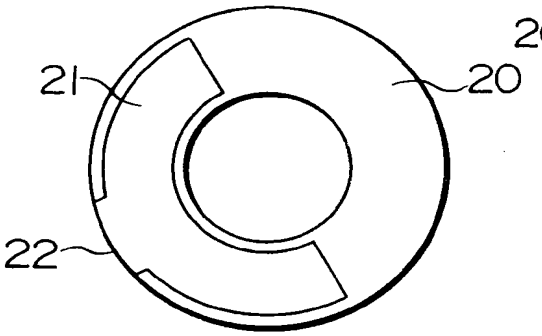


FIG. 9C

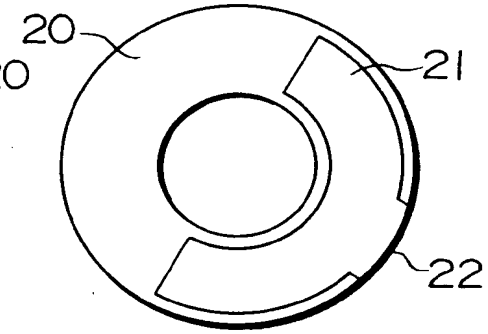
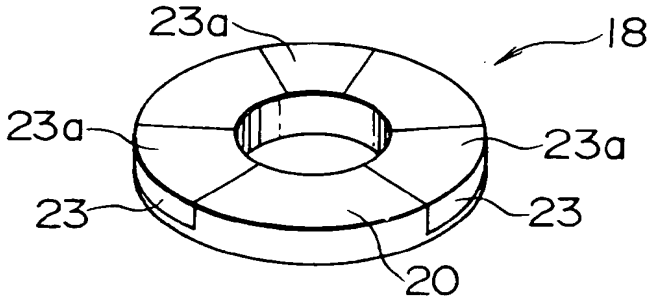


FIG. 10



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Application Number
EP 92 31 1277
PAGE2

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	PATENT ABSTRACTS OF JAPAN vol. 2, no. 118 (E-78)(6780) 30 September 1978 & JP-A-53 084 107 (MATSUSHITA DENKO K.K.) 25 July 1978 * abstract *	1	
A	DE-B-2 357 127 (MITSUBISHI MINING & CEMENT CO. LTD.) * figure 2 *	1	
A	US-A-4 329 605 (D.F.ANGI & AL.) * column 3, line 30 - line 52; figure 5 *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 001, no. 119 (E-052)11 October 1977 & JP-A-52 051 504 (MATSUSHITA ELECTRIC WORKS LTD) 25 April 1977 * abstract *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	01 APRIL 1993	LEOUFFRE M.

CATEGORY OF CITED DOCUMENTS

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